National Park Service

Geographic Information System (GIS) Data Specifications for
Resource Mapping, Inventories, and Studies

National GIS and Inventory & Monitoring Programs
National Park Service

Introduction
National Park Service (NPS) Resource Management, Inventory and Monitoring, and other program area projects and activities generate both spatial and tabular data sets. These spatial data sets are incorporated into park, regional, and national databases and made available to a wide range of users. Conformance to certain standards and product specifications is necessary to ensure these data sets are discoverable and usable by data consumers.   This document provides general standards for spatial data collection and submission. Park-, network-, region-, and program-level project managers may require further specifications and this may vary from project to project and any deviation from these standards must be approved by the project manager.

Organizational Justification
The NPS supports and organizes national geographic data development for public consumption through ParkNet's Interactive Map Center and the Natural Resource and GIS Metadata and Data Store (NR-GIS Data Store) and are accessed by millions of people every week via the Internet. The NR-GIS Data Store is an official node of the National Spatial Data Infrastructure, required by Executive Order 12906. This national effort saves each region and program office from having to support a similar infrastructure and developing regional expertise to carry out this federally mandated service. These activities also reduce demand on individual parks, regions, and program GIS staff, by making these data available to the public and NPS sites through conventional web resources.

March 11, 2005

I. Deliverables
Complete and verified data will be delivered via CD-ROM/DVD, or via electronic data transfer (e.g., FTP), or via an approved method by the Project Manager. Each CD/DVD should be in -R format, so that once it is written it cannot be modified. The products delivered to the project manager will contain the following items:

A. Required
- Descriptive Document
- Spatial data
- Associated data table(s) or relational Microsoft Access Database
- FGDC compliant Metadata

B. As Specified by contract
- Linked document(s)
- Linked graphics or digital photographs

II. Descriptive Document
A Microsoft Word document (and/or ASCII text file if specified) describing the data set will accompany any submission and provide all necessary information for understanding the submittal. This includes but is not limited to the following:
- Contents of the CD/DVD or .zip file
- Version and date of the data
- Sensitive data issues (if any exist or as appropriate)
- Contact information for those responsible for the data
- Short description of data themes. Limit to one to two sentences of each theme.
- Linking fields (to documents, Microsoft Access database, digital photographs)

Example of a Descriptive Document for a park with alpha code "*CODE*" can be used as a template.

A CD-R in ISO 9660 format contains the following file:

CODEBird.Zip containing the following files:

- *CODE*_BirdSurvey_Readme.Doc (this Descriptive Document)
- *CODE*_Bird_File_Names.Doc (naming convention or codes used for file names - if applicable)
- *CODE*_BirdSurvey2000.Doc – a descriptive document for the *Code* 2000 bird survey.
- *CODE*Bird.e00 – exported ArcINFO Coverage
- *CODE*Bird.lyr – ArcGIS layer file
- *CODE*Bird.xml– FGDC metadata XML format metadata file
- *CODE*Bird.mdb – Microsoft Access database
- *CODE*_Bird_Data_Dict.Doc – descriptions of attributes and data tables

This first version of bird data was completed on 05/28/02.

None of the information contained in this data set is considered sensitive.

The data were created by Joe Smith of the National Park Service, Some NPS Project, phone – (999) 999-9999.

Short description of data themes. Limit to one to two sentences of each theme.

The Key Field "LocationID" links the Access database and the coverage.

III. Spatial Data
There are several ways in which spatial data can be represented in a GIS including points, lines, polygons, or rasters/images. **Determining which representation(s) is appropriate for your study involves consideration of scale and study goals. Prior to data collection, this issue should be addressed and resolved in the project study plan in consultation with the project or data manager. Additionally, network and park data management plans may dictate the appropriate format.**

A. File Naming Conventions
A clear and meaningful file name should be used that conveys the nature of the data, subject, and park unit represented. All data and related file names should not contain spaces or special characters. An underscore may be used to make field names more readable (example Code_birdsurvey). Field names should conform to ArcGIS field naming limitations.

B. Coordinate Systems

All spatial data collected or submitted for national, regional, or network NPS programs shall be geo-referenced with projection information defined in the data file that is submitted.   All spatial data will be provided in the standard regional-scale projection(s). This will generally be UTM, NAD83. See Appendix 1 for details and exceptions. Projection specifications shall be approved by the Project Manager.

C. Spatial Data Formats

The data format(s) should be clearly stipulated and agreed upon with contractors or cooperators before data collection and processing start. If there are questions about choosing a data format, converting between formats, or non-standard formats, contact the park, network, region, or program GIS/data managers..

Vector Data

All vector data will be supplied as an ArcINFO interchange file (*.E00) and/or ArcView Shapefile, or an ESRI ArcGIS Geodatabase compatible with the current version of ArcINFO.

> **i. ESRI ArcINFO Coverage/export file** Data developed in ArcINFO coverage format should be exported to an Arc Interchange file (.E00 file) (ArcGIS 8.x .E00 files should include the metadata .XML file from ArcCatalog). All coverages should be created as double precision data sets. If the data set was originally obtained in single precision, convert it to double precision before submitting. All coverages should be topologically clean and correct. All coverages will contain complete well defined projection information.

> **ii. ESRI Shapefile** Shapefile format shall be used only if an ArcINFO coverage does not exist. The shapefile format includes at a minimum the .SHP, .DBF, .SHX and PRJ files.   Shapefiles from ArcGIS files should include the metadata .XML and projection .prj files.

> **iii. ESRI ArcGIS Geodatabase** Data delivered as an GDB shall be delivered as the Microsoft access .MDB that is the GDB.   A geodatabase (short for geographic database) is a physical store of geographic information inside a relational database management system (RDBMS). A personal geodatabase is stored as a Microsoft Access file. The schema should be supplied by the NPS or the development of the schema should be specifically addressed in the project plan.

Raster Data

All cell based data sets or grids will be supplied as an ArcINFO GRID and/or ArcINFO interchange file, compatible with the current version of ArcGIS. All geo-referenced digital aerial photography and imagery, are to be supplied either as a ERDAS Imagine File, 8 bit grayscale GeoTiff or 24 bit RGB GeoTiff, or a tagged

image file format (.TIFF) files with any associated geo-reference information. Digital aerial photography and imagery may be acceptable in other data formats, which are specified below,.

> **iv. ArcINFO GRID File** This is the preferred format for **non-imagery** raster data. This is a ESRI format that supports 32-bit integer and 32-bit floating-point raster grids. Grids are useful for representing geographic phenomena that vary continuously over space and for performing spatial modeling and analysis of flows, trends, and surfaces such as hydrology. Generally, GRID themes should be delivered as .E00 files as stipulated above. It is recommended that large Grid themes be submitted as separate compressed workspaces because .E00 files may be extremely large and unwieldy.   All data submitted in Grid format will have well defined projection information.

> **v. ERDAS Imagine file** Imagine files (.IMG) will contain well defined projection files associated with them. Pyramid files (.RRD) shall be included if available.

> **vi. GeoTIFF v1.0** A raster format with geo-referencing stored in the header of the file. All data submitted in GeoTiff format will have well defined projection files associated with them

> **vii. .TIFF** TIFF files must include world files and will have well defined projection files associated with them.

Special Cases

> **AutoCAD file with world file or .DXF export** Generally, this format is NOT recommended and will be accepted only upon the direct specification, approval, and documentation of the project and data managers. If used, an AutoCAD release 14 (release 2000 for ArcGIS 8.x) or lower drawing (.DWG) file with a georeferenced world file (.WLD) and/or AutoCAD release 13 .DXF format file with georeferenced coordinates should be required. Data submitted in this format must be exported from AutoCAD using the etransmit function so as to include all information stored in the drawing. Non-geographic elements such as drawing borders, title blocks,north arrows, detail drawings, and title sheets shall not be included in DXF export files or shall be placed on Layer 0. All blocks shall be exploded prior to creation of DXF file. The "16 decimal places" option must be specified during the DXFOUT ("Save As" from the pull down menu) command. This will preserve double precision accuracy.

> **Other possible raster file formats** that may be utilized natively as an ArcGIS layer include .BMP, .BSQ, .BIL, .BIP, ERMapper, IMPELL Bitmaps, Image Catalogs, .JPEG,JPEG2000, MrSID, and Sun Rasterfiles, but applicable header or world files must be used (which makes .BMP, .JPEG, and Sun Rasterfiles unacceptable). All aforementioned formats will have well defined projection files associated with them. Again, the appropriate

project manager(s) must approve any deviation from the preferred standards discussed above.

C. Collection methods
Several approaches to capturing digital data can be employed including digitizing features from maps or aerial photographs, and GPS (Global Positioning System) collection. The appropriate method should be determined in the study plan and after consultation with the project, resource, or data manager.

When digitizing features from maps or photographs, the source, scale, date, and methods (i.e., process steps) shall be recorded in the Metadata and discussed in the Descriptive Document. When using GPS collection, the GPS unit type, model, averaging method used for static surveying, error correction technique and GPS quality filters employed shall be recorded in the Metadata and discussed in the Descriptive Document.

E. Scale and Spatial Resolution
Project planners should contact appropriate GIS or data management staff for specific scale and spatial resolution requirements for vector and raster/image data which should be clearly specified in the contract or cooperative agreement.

F. Horizontal and Vertical Accuracy
All spatial data collected shall be analyzed for their spatial accuracy and shall meet or exceed the National Map Accuracy Standards for the appropriate scale (for more information see http://mapping.usgs.gov/standards/ or Appendix 2). Longitude and Latitude coordinates for geographic data should be recorded to a minimum 5 significant digits to the right of the decimal point and stored in double precision attribute or database fields.

IV. Attribute Data
Simple attribute data such as that used for map symbolization shall be delivered as part of the ArcGIS feature attribute table. Complex attributes shall be delivered in a well-structured relational database format as a Microsoft Access .MDB file using current versions of Microsoft Access. Map features and database records shall share a common unique identifier or primary key that relates the map feature to the table record

The ArcINFO coverage/shapefile format is not ideal for storage and management of complex relational data such as 1:many relationships and data normalization, NPS project managers may request that relational attribute data shall be stored either in a separate, well-structured relational database system or in a geodatabase data format.

V. Quality Control
Accuracy assessments of spatial and attribute data are project specific. Project planners should contact appropriate GIS or data management staff for specific details. QA/QC procedures will be documented by the Contractor in the appropriate Metadata sections.

VI. Metadata
All data submitted shall include metadata that meets the minimum NPS content standard for metadata. This content standard, the NPS Metadata Profile (see

http://science.nature.nps.gov/nrdata/docs/metastds.cfm), contains minimally-compliant FGDC metadata elements (FGDC metadata; see http://geology.usgs.gov/tools/metadata/) in addition to NPS-specific elements.   For NPS Profile Metadata Authoring Guidance relevant to natural resource data, see http://science.nature.nps.gov/nrdata/docs/metahelp/createhelp.cfm.   XML templates for NPS Profile-format metadata may be found at: http://science.nature.nps.gov/nrdata/docs/metahelp/createhelp.cfm as well.

The metadata must be located in the same directory as the data and when appropriate attached to that data. The metadata should be delivered in extensible markup language with an .XML extension.

If applicable, NBII Biologic Data Profile metadata elements (BDP metadata; see http://www.nbii.gov/datainfo/metadata/standards/) should be included in the metadata record.

The metadata record must be parsed with no errors prior to submission using the Metadata Parser (MP) provided by the FDGC. To learn more about getting started with FGDC metadata or using the MetaParser program see http://geology.usgs.gov/tools/metadata/ or contact your project or data manager. For complete information on FGDC metadata see http://www.fgdc.gov.

Recommended metadata authoring tools include:
- ArcCatalog is the primary recommended metadata authoring tool
- The NPS MWR ArcGIS Metadata Tools Extension (http://science.nature.nps.gov/im/units/mwr/gis/) to author and parse geospatial metadata.
- The NPS Metadata Editor (when available) to generate any type of NPS metadata, including Biological Data Profile metadata.
- NPS Dataset Catalog (http://science.nature.nps.gov/im/apps/datacat/) to export XML metadata in NPS Profile format.

Several example FGDC-compliant metadata records and browse graphics may be reviewed at http://www.nps.gov/gis/data_info/.

Specifications for the attributes and database tables attached or linked to the spatial data must be documented in the "Entity and Attribute Information " section of the FGDC metadata and include:
- Attribute Label (field name)
- Attribute Definition (field description)
- Field format (not an FGDC field, this field is part of either the ESRI or NPS metadata profile extensions to the FGDC standard)
- Valid values (Attribute Domain Values)

The NPS Dataset Catalog tool noted above will harvest entity and attribute information from database files.

Prior to the metadata being loaded into the NR-GIS Data Store, NPS staff will be responsible for inserting the DOI solicitor approved NPS data distribution liability statement and the appropriate NPS Info Tags in the NPS_Information Section.

VII. Linked Documents

Project documents such as user manuals, detailed map unit descriptions, and site photographs can be linked to map features through "hot linking". Hot linking (hyper linking) allows the user to click a map feature and have a related document open and jump to the chapter associated with an attribute of that map feature. If an associated document is included with the intention of hot linking (hyper linking) the following is required:

A. HTML Documents (preferred method)

- The document(s) shall be an HTML formatted file.
- The document(s) will include a table of contents with separate listings and anchors for each "topic" or description that relates to a GIS feature.
- Include a separate tabular list of which "topics" correspond to each linking field value in the GIS theme (i.e. the key values for linking the document to the GIS).

For more information about linking documents to GIS features, see the NPS Theme Manager

B. Microsoft Word Documents (for conversion to Windows Help Files). This option is strongly discouraged

- The document(s) shall be a Microsoft Word formatted file.
- The document(s) will include a table of contents with separate listings for each "topic" or description that relates to a GIS feature (e.g., extensive textual descriptions of each and every feature of a theme).
- Include a separate tabular list of which "topics" correspond to each linking field value in the GIS theme (i.e. the key values for linking the document to the GIS).

C. Linked Graphics or Digital Photographs

If any linked digital photographs are included with the data set, they should be in a format that is readable in ESRI's ArcGIS. Image types that can be directly hot linked (hyperlinked) to a layer in ArcMap include .GIF, .JPEG/.JPG, MacPaint, Microsoft DIB, Sun Raster files, .TIFF, .TIFF/LZW compressed, X-Bitmap, and .XWD.

Images and graphics shall be organized in a file folder or directory structure that provides a logical hierarchical format. The directory structure recommended by the national I&M Program may be downloaded at http://science.nature.nps.gov/im/gisprogram.htm. .

Map features with linked graphics/photographs should contain a GIS attribute field that records the relative directory path and file name. The suggested field name is "Images." Map layers should have meaningful names that relate to the map theme and its attributes, and digital image file names should be encoded with this value. Any file coding schemes that are used should be documented and included in the Descriptive Document.

APPENDIX 1 Coordinate Systems
Projection specifications shall be approved by the Project Manager.

Park Unit Data Standard In general, the standard projection for most park-level GIS layers is Universal Transverse Mercator with the following parameters:

•	**Projection**	Universal Transverse Mercator
•	**Zone**	Zone value
•	**Datum**	North American Datum 1983
•	**Spheroid**	GRS 1980
•	**False Easting**	0
•	**False Northing**	0
•	**Units**	Meters

Park Unit Standards for Exceptions In addition to the system noted above, several NPS units require additional specific standards for data delivery. If the park crosses UTM zone boundaries, it is recommended that only one zone, or a different coordinate system, should be used. Parks in Hawaii and other Pacific islands will be in the datum and projection specified by each park. Because of their unique geographic location, the NPS Alaska Region also requires a specific datum and projection as noted below.

> **National Capital Region** The standard projection for National Capital Region parks use the following parameters:

•	**Projection**	State Plane
•	**Datum**	North American Datum 1983
•	**Spheroid**	GRS 1980
•	**Units**	feet

> **Alaska Region** The standard projection for Alaska Region parks uses the following parameters:

•	**Projection**	Alaska Albers Equal Area
•	**Datum**	North American Datum 1983
•	**Spheroid**	GRS 1980
•	**False Easting**	0
•	**False Northing**	0
•	**Central Meridian**	-154 00 00
•	**1st Standard Parallel**	55 00 00
•	**2nd Standard Parallel**	65 00 00
•	**Units**	Meters

APPENDIX 2 National Map Accuracy Standards

http://mapping.usgs.gov/standards/

Map Accuracy Standards

Fact Sheet FS-171-99 (November 1999)

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Map Accuracy

An inaccurate map is not a reliable map. "X" may mark the spot where the treasure is buried, but unless the seeker can locate "X" in relation to known landmarks, the map is not very useful.

The U.S. Geological Survey (USGS) publishes maps and other products at high levels of accuracy. Dependability is vital, for example, to engineers, highway officials, and land-use planners who use USGS topographic maps as basic planning tools.

As a result, the USGS makes every effort to achieve a high level of accuracy in all of its published products. An important aim of its accuracy control program is to meet the U.S. National Map Accuracy Standards.

National Map Accuracy Standards

To find methods of ensuring the accuracy of both location (the latitude and longitude of a point) and elevation (the altitude above sea level), the American Society for Photogrammetry and Remote Sensing - an organization actively involved in the science of making precise measurements from photographs (photogrammetry) and acquiring information from aerial photographs and satellite image data (remote sensing) - set up a committee in 1937 to draft accuracy specifications. Sparked by this work, agencies of the Federal Government, including the USGS, began their own inquiries and studies of map accuracy standards. In 1941, the U.S. Bureau of the Budget issued the "United States National Map Accuracy Standards," which applied to all Federal agencies that produce maps. The standards were revised several times, and the current version was issued in 1947. (The standards are printed at the end of this factsheet.)

As applied to the USGS 7.5-minute quadrangle topographic map, the horizontal accuracy standard requires that the positions of 90 percent of all points tested must be accurate within 1/50th of an inch (0.05 centimeters) on the map. At 1:24,000 scale, 1/50th of an inch is 40 feet (12.2 meters). The vertical accuracy standard requires that the elevation of

90 percent of all points tested must be correct within half of the contour interval. On a map with a contour interval of 10 feet, the map must correctly show 90 percent of all points tested within 5 feet (1.5 meters) of the actual elevation.

All maps produced by the USGS at 1:250,000 scale and larger are prepared by methods designed to meet these accuracy standards and carry the statement, "This map complies with National Map Accuracy Standards." Exceptions to this practice involve areas covered by dense woodland or obscured by fog or clouds; in those areas, aerial photographs cannot provide the detail needed for precise mapping. The USGS tests enough of its maps to ensure that the instruments and procedures the Survey uses are producing maps that meet the U.S. National Map Accuracy Standards.

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How the Survey Maintains Map Accuracy

In 1958, the USGS began systematically testing the accuracy of its maps. Presently, accuracy testing is performed on 10 percent of the mapping projects at each contour interval as a method of controlling overall quality. It is rare for a 7.5-minute map to fail the test, but this happens on occasion.

In testing a map, the USGS experts select 20 or more well-defined points; a typical point would be the intersection of two roads. Positions are established on the test points by field teams using sophisticated surveying techniques to determine positions from aerial photographs. Field survey methods are the only tests accepted for official accuracy testing. Positions must be obtained by surveys of a higher accuracy. Vertical tests are run separately to determine precise elevations. The mapped positions are checked against the field and (or) photogrammetrically determined positions results. If the map is accurate within the tolerances of the U.S. National Map Accuracy Standards, it is certified and published with the statement that it complies with those standards.

By such rigorous testing of some of its maps, the USGS is able to determine that its procedures for collecting map information ensure a high level of map accuracy.

Factual Errors

There are other kinds of errors in mapmaking. Names and symbols of features and classification of roads or woodlands are among the principal items that are subject to factual error. Mapmakers cannot apply a numerical value to this kind of information; they must rely on local sources for their information. Sometimes the local information is wrong. Sometimes names change or new names and features are added in an area. The USGS cartographers and editors check all maps thoroughly and, as a matter of professional pride, attempt to keep factual errors to a minimum.

"Errors" resulting from selection, generalization, and displacement are necessary results of mapping complex features at reduced scales. In congested areas, large buildings may

be plotted to scale and the smaller buildings may have to be omitted; in showing buildings of irregular shape, small wings, bays, and projections usually are disregarded, and the outline is shown in general form. At map scale, it may not be possible to show each of several closely spaced linear features in its correct position. In such cases, one feature, such as a railroad, is positioned in its true location and others, such as parallel roads or rivers, are displaced the minimum amount necessary to make each symbol legible or are omitted to make the highest priority symbol legible.

United States National Map Accuracy Standards

With a view to the utmost economy and expedition in producing maps that fulfill not only the broad needs for standard or principal maps, but also the reasonable particular needs of individual agencies, the Federal Government has defined the following standards of accuracy for published maps:

1. Horizontal accuracy. For maps on publication scales larger than 1:20,000, not more than 10 percent of the points tested shall be in error by more than 1/30 inch, measured on the publication scale; for maps on publication scales of 1:20,000 or smaller, 1/50 inch. These limits of accuracy shall apply to positions of well-defined points only. Well-defined points are those that are easily visible or recoverable on the ground, such as the following: monuments or markers, such as bench marks, property boundary monuments; intersections of roads and railroads; corners of large buildings or structures (or center points of small buildings). In general, what is well-defined will also be determined by what is plottable on the scale of the map with-in 1/100 inch. Thus, while the intersection of two roads or property lines meeting at right angles would come within a sensible interpretation, identification of the intersection of such lines meeting at an acute angle would not be practicable within 1/100 inch. Similarly, features not identifiable upon the ground within close limits are not to be considered as test points within the limits quoted, even though their positions may be scaled closely upon the map. This class would cover timber lines and soil boundaries.
2. Vertical accuracy, as applied to contour maps on all publication scales, shall be such that not more than 10 percent of the elevations tested shall be in error by more than one-half the contour interval. In checking elevations taken from the map, the apparent vertical error may be decreased by assuming a horizontal displacement within the permissible horizontal error for a map of that scale.
3. The accuracy of any map may be tested by comparing the positions of points whose locations or elevations are shown upon it with corresponding positions as determined by surveys of a higher accuracy. Tests shall be made by the producing agency, which shall also determine which of its maps are to be tested, and the extent of such testing.
4. Published maps meeting these accuracy requirements shall note this fact in their legends, as follows: "This map complies with National Map Accuracy Standards."
5. Published maps whose errors exceed those aforestated shall omit from their legends all mention of standard accuracy.

6. When a published map is a considerable enlargement of a map drawing (manuscript) or of a published map, that fact shall be stated in the legend. For example, "This map is an enlargement of a 1:20,000-scale map drawing," or "This map is an enlargement of a 1:24,000-scale published map."

To facilitate ready interchange and use of basic information for map construction among all Federal mapmaking agencies, manuscript maps and published maps, wherever economically feasible and consistent with the use to which the map is to be put, shall conform to latitude and longitude boundaries, being 15 minutes of latitude and longitude, or 7.5 minutes, or 3.75 minutes in size.